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(54) Clutch slip drive apparatus for a motor vehicle

(57) For the reduction of torsional vibrations in the drive line of a motor vehicle and for the reduction of the consequent noises the friction clutch (5) arranged between internal combustion engine (1) and gear (9) is controlled by a slip-regulating circuit the ideal value emitter (43) of which controls the slip in dependence upon the sensed solid-conducted noise level. The slip is controlled so that it increases with increasing solid-conducted noise level. The maximum value of the slip is limited in dependence upon the engine rotation rate, the maximum value decreasing to zero with rising engine rotation rate.

FIG.1

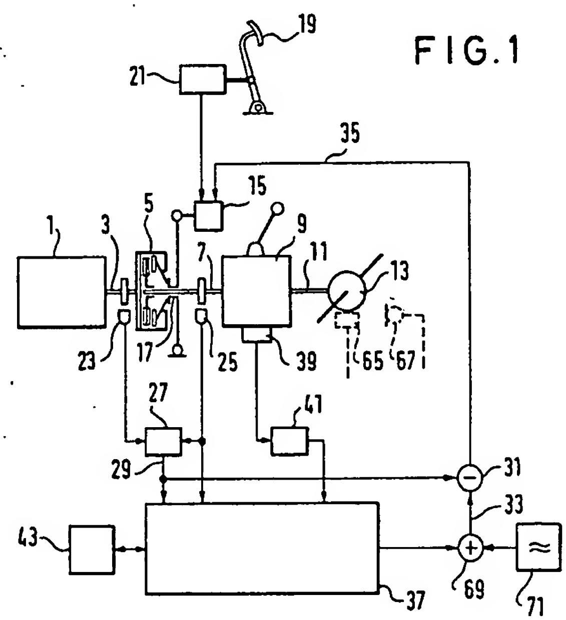

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FIG.1

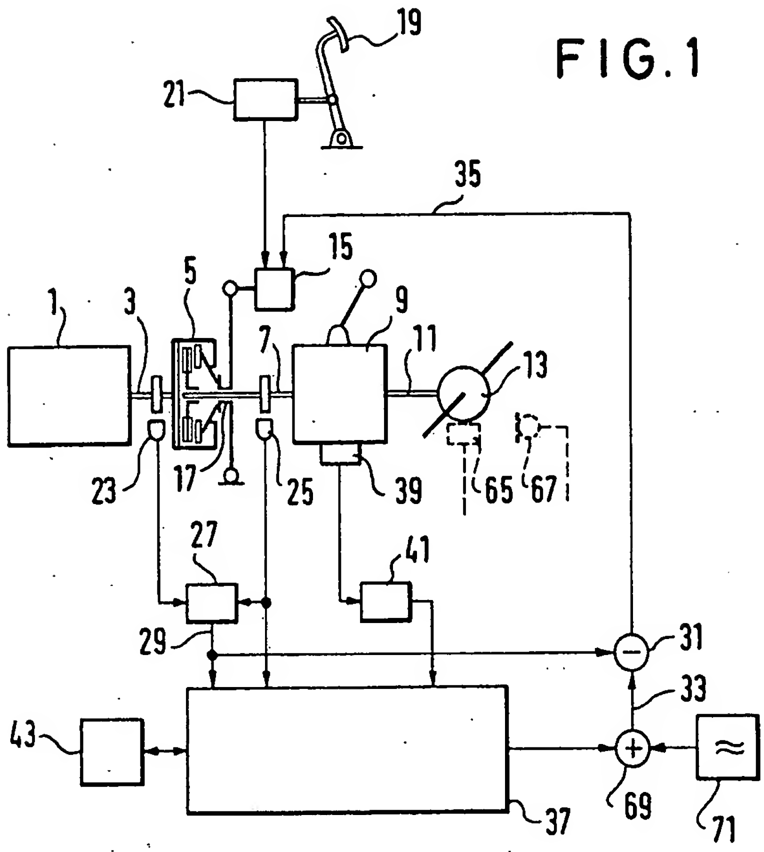

FIG.2

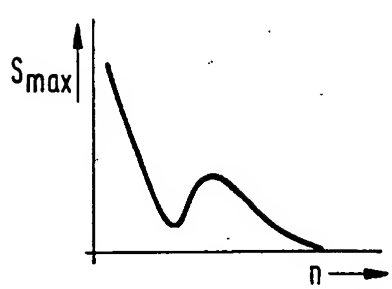

FIG.3

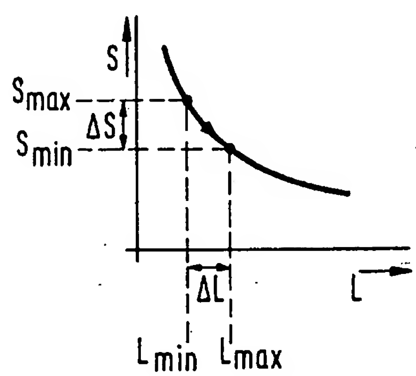

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FIG. 4

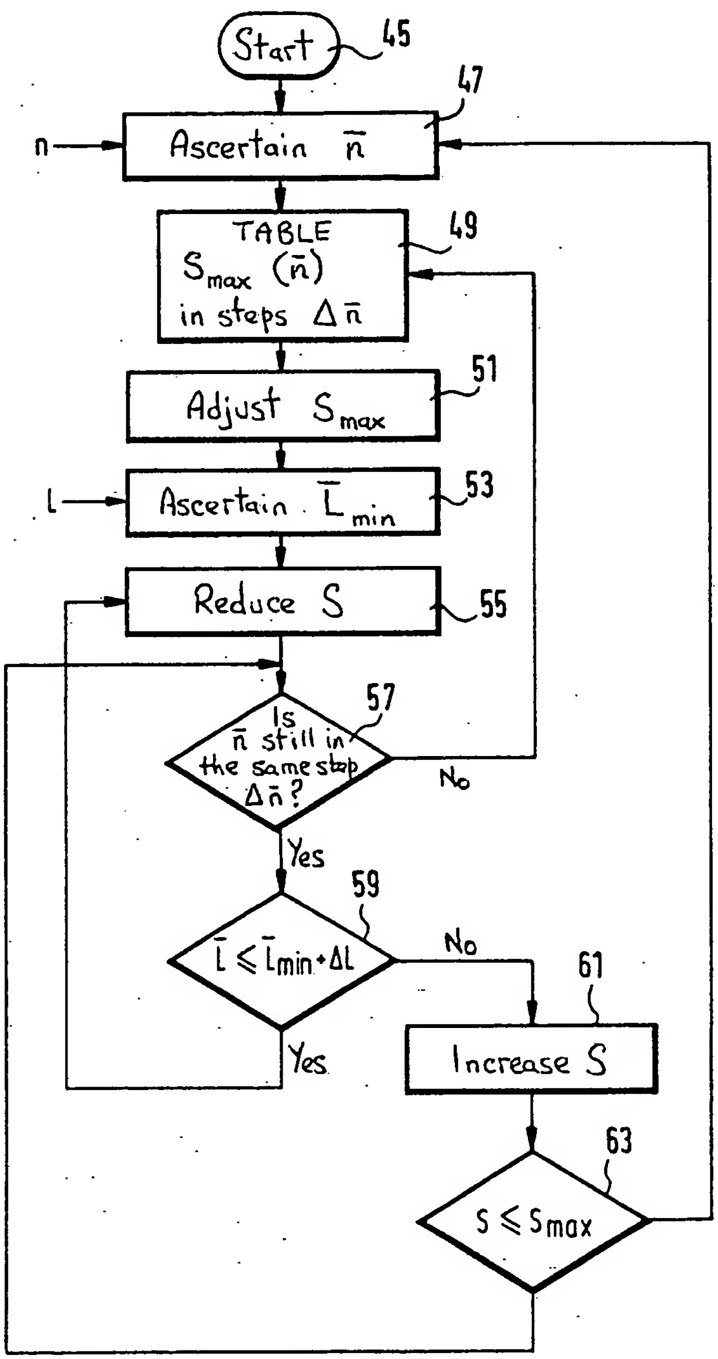
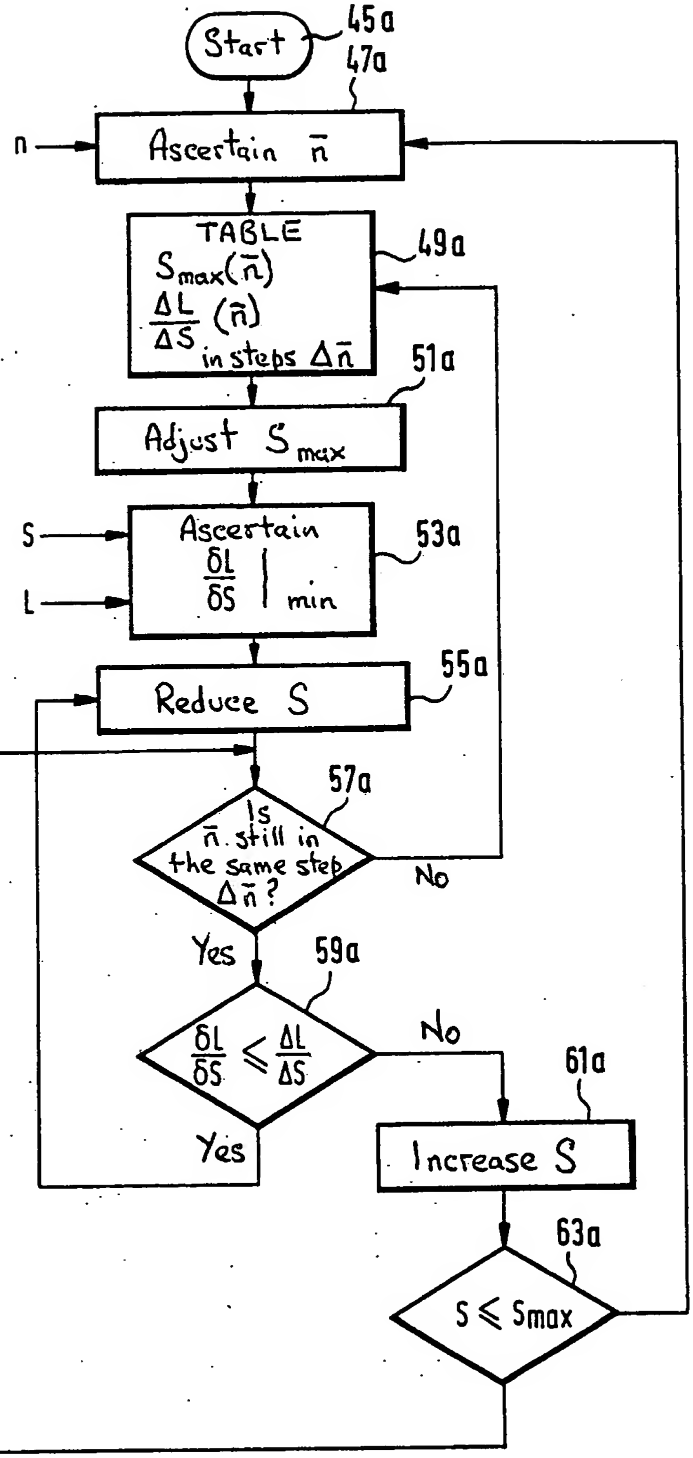


FIG. 5


Start
45a
47a
n
Ascertain $\bar{n}$
TABLE
$S_{max}(\bar{n})$
$\frac{\Delta L}{\Delta S}(\bar{n})$
in steps $\Delta\bar{n}$
49a
51a
Adjust S_{max}
S
L
Ascertain
$\frac{\delta L}{\delta S}\Big|_{min}$
53a
Reduce S
55a
57a
Is $\bar{n}$ still in the same step $\Delta\bar{n}$?
No
Yes
59a
$\frac{\delta L}{\delta S} \leqslant \frac{\Delta L}{\Delta S}$
No
Yes
61a
Increase S
63a
$S \leqslant S_{max}$

SPECIFICATION

Drive apparatus for a motor vehicle

The invention relates to a drive apparatus for a motor vehicle according to the opening statement of Patent Claim 1.

It is known from British Patent Specification No. 2,145,492 to damp torsional vibrations in the drive line of a motor vehicle due to the fact that the friction clutch arranged in the torque transmission path between internal combustion engine and gear is slightly opened and a predetermined slip of the clutch is permitted. In the known drive arrangement the slip, that is the difference between the output rotation rate of the internal combustion engine and the input rotation rate of the gear, is controlled by means of a rotation rate sensor detecting the rotation rate of the engine. In the known arrangement however operational situations can arise in which the clutch is unnecessarily heated by the slip set in dependence upon the engine rotation rate, and fuel is unnecessarily consumed. Furthermore the wear of the clutch increases. In the known drive arrangement the slip can be limited only with difficulty to those rotation rate ranges in which characteristic resonances of the drive line occur, or to torsional vibration-generating operational situations as for example in the case of rapid variations of the drive moment.

From DE-OS No. 3,415,092 another drive arrangement is known in which the friction clutch is set to a slight slip for torsional vibrations in the drive line. The slipping operation of the clutch is triggered by an acceleration sensor fitted on the gear box.

It is an object of the invention so to improve a drive apparatus for a motor vehicle, in which a slip of the friction clutch is set for the damping of gear noises and for the damping of torsional vibrations, that the thermal loading and wear of the clutch are reduced and a regulation of the slip is carried out more exactly.

This object is achieved by the features stated in the characterising part of Patent Claim 1.

Within the scope of the invention the slip-regulating arrangement regulates the friction clutch, according to a for example empirically ascertained characteristic of the slip necessary for the vibration damping and noise reduction, in dependence upon the engine rotation rate or the gear-input rotation rate. Information as to the magnitude of the desired slip in dependence upon the rotation rate can be stored for example in a table store of the slip-regulating arrangement. The slip-rotation rate characteristic is however dependent upon a plurality of parameters including not leastly the working situations and the equipment differing from vehicle to vehicle. Furthermore the characteristic can vary in the course of the life of the vehicle. In order to satisfy these requirements the predetermined slip-rotation rate characteristic must be set as a rule to slip values which lie above the slip values actually necessary in the individual case. However excessive slip values increase the thermal loading and the wear of the clutch.

Within the scope of the invention the vibration sensor responds to vibrations in the acoustic frequency range and delivers a signal corresponding to the noise level.The slip-regulating arrangement stores a slip-rotation rate characteristic with slip values for the maximum permissible slip of the clutch. This characteristic however determines only a limit value which must not be exceeded in the operation of the clutch, in order to avoid clutch damage. In operation the slip-regulating arrangement reduces the actual slip in dependence upon the noise level detected by means of the vibration sensor. In other words the slip is reduced to a value lower than the maximum permissible slip, if the noise level caused by the vibrations permits this. The vibration sensor can here respond to solid-conducted sound, for example of the gear, or equally to air-conducted sound, for example in the passenger compartment of the vehicle.

In a preferred form of embodiment the slip-regulating arrangement comprises a control system which in dependence upon the signal of the vibration sensor generates a control parameter value which varies with the signal of the vibration sensor. The slip of the clutch is adjusted in dependence upon this control parameter value; since the noise level detected by the vibration sensor depends not leastly upon the momentary operating conditions of the vehicle, the control system adjusts the slip of the clutch firstly in accordance with the predetermined slip-rotation rate characteristic to the maximum permissible slip, and then the minimum noise level achievable in the momentary operational situation results. On the basis of the control parameter value resulting when the maximum permissible slip is set, the slip is reduced preferably in steps until a second limit value of the control parameter, determined by the maximum desired noise level, is achieved.

The control parameter can be the time mean value of the signal of the vibration sensor, averaged over a predetermined time interval. The slip-regulating arrangement in this form of embodiment reduces the slip by steps until the noise level has increased by a predetermined, for example constant value beyond the noise level value occurring at maximum permissible slip.

The response time of the slip-regulating arrangement can be shortened in comparison with the form of embodiment as explained above if the quotient of a variation of the noise level in relation to a variation of the slip is utilised as control parameter. Between the

slip and the noise level there exists a sufficiently unambiguously empirically ascertainable non-linear relationship, the characteristic of which with decreasing slip and increasing noise level displays an asymptotic behaviour. By way of example in a table store of the slip-regulating arrangement limit values of the quotient can be stored in dependence upon the rotation rate, which permit the slip-regulating arrangement to reduce the quotient achieved at maximum permissible slip, step-by-step until this stored limit value is reached.

The vibration sensor can be an acceleration sensor which responds to vibration accelerations, for example of the gear, the gear-change fittings or a differential gear following the gear. The acceleration sensor preferably detects accelerations transversely of the direction of travel in the plane of the roadway, in order to exclude interference accelerations based on driving operation. Alternatively or possibly even additionally the vibration sensor can comprise a microphone or the like arranged in the passenger compartment of the motor vehicle. The vibration sensor can be followed by filter circuits which selectively respond to the noise spectrum generating the drive noises.

Within the scope of the invention no further influencing values dependent upon driving operation, for example no moment-dependent control action, are necessary. The slip-regulating circuit works when the drive line is operating in traction as well as in over-run. Additional signals, for example signals which effect a lead of the regulating system in dependence upon the time constant, can equally well be introduced into the regulating circuit. An oscillator which modulates the slip of the clutch with an amplitude which is small compared with the slip amplitude is also of advantage for the reduction of torsional vibrations in the drive line. The modulation frequency should here be greater than the ignition sequence frequency and amount to about 2 to 10 times the ignition sequence frequency. Due to the superimposition of the modulation vibration which periodically reduces and increases the slip with the modulation frequency, inherent frequency vibrations of the drive line can be reduced, if not entirely avoided. However the modulation frequency must not be an integral multiple of the energising frequency.

Furthermore the slip-regulating arrangement can be utilised for monotirong the clutch work which thermally loads the clutch, the momentary slip being reduced so that the heat removal of the clutch is guaranteed.

Examples of embodiment of the invention are to be explained in greater detail hereafter by reference to drawings, wherein:–

Figure 1 is a diagrammatic block circuit diagram of a drive arrangement for a motor vehicle;

Figure 2 shows a diagram showing the maximum permissible slip S_{max} in dependence upon the gear-input rotation rate n;

Figure 3 shows a diagram showing the desired slip S in dependence upon the noise level L;

Figure 4 shows a computer operation diagram to explain the manner of operation of a first form of embodiment of the drive arrangement as represented in Fig. 1 and

Figure 5 shows a computer operation diagram of a second form of embodiment of the drive arrangement as represented in Fig. 1.

Fig. 1 shows diagrammatically the drive apparatus of a motor vehicle with an internal combustion engine 1, the crank-shaft 3 of which is connected through a friction clutch 5 of conventional construction type with an input shaft 7 of a manually changeable gear 9. An output shaft 11 of the gear 9 drives at least one of the wheel pairs, for example the rear wheels of the motor vehicle, through a differential gear 13. The friction clutch 5 is controlled by a servo-positioning drive system 15 between a completely engaged and a completely disengaged position of its releaser 17. A positioner 21 operable by a clutch pedal 19 in the usual way controls the clutch operation. The gear 9 can alternatively also be formed as an automatic gear the ratios of which are shifted in dependence upon a programme control. In this case the programme control also controls the positioner 21.

In the drive line of the motor vehicle formed by the components 1, 5, 9 and 13 torsional vibrations can occur which in conventional motor vehicles are damped by torsional vibration dampers, especially in the clutch disc of the friction clutch. In the drive line according to Fig. 1, torsional vibrations and noises connected therewith, especially of the gear 9, are damped in that in driving operation the friction clutch 5 is not completely engaged during the transmission of the drive torque, but is slightly opened so that it transmits the torque with a slip of predetermined magnitude. The slip is regulated by means of a slip-regulating circuit diagrammatically represented in Fig. 1. To ascertain the slip of the friction clutch 5 the output rotation rate of the internal combustion engine 1, that is to say the input rotation rate of the friction clutch 5, is measured by means of a rotation-rate sensor 23. The output rotation rate of the friction clutch 5, that is the input rotation rate of the gear 9, is ascertained by means of a rotation rate sensor 25. A subtraction circuit 27 delivers at its output 29 a signal proportional to the rotation rate difference and thus to the actual slip. A subtraction circuit 31 subtracts the actual signal from an ideal signal supplied at 33 and representing the desired slip and delivers through a conductor 35 an error signal which controls the drive 15 of the friction clutch 5 independently of the actuation of the clutch pedal 19, so that the clutch 5 works with the ideal slip.

The magnitude of the ideal slip is controlled by a programme control system 37 for example in the form of a micro-processor or the like for the one part in dependence upon the input rotation rate n of the gear 9 detected by means of the rotation rate sensor 25, the actual slip signal and a noise level signal L detected by means of an acceleration sensor 39 for example on the housing of the gear 9. The acceleration sensor 39 detects the level of vibration accelerations transverse to the direction of travel of the vehicle and parallel to the roadway plane. Vibration accelerations in this orientation are only slightly influenced by the acceleration forces caused for example by roadway irregularities during driving. The acceleration sensor 39 is connected to the programme control system 37 through a filter circuit 41 which is attuned to the spectrum of the sound frequencies occurring in the drive line. The programme control system 37, explained in greater detail below, limits the ideal signal, representing the desired slip, to a maximum permissible value of the slip S_{max}, namely in dependence upon the rotation rate n of the gear-input shaft 7 detected by means of the rotation rate sensor 25. Fig. 2 shows the characteristic of the maximum permissible slip S_{max} in dependence upon the rotation rate n. The characteristic is measured for example empirically so that for the one part the thermal loading of the clutch remains within permissible limits and for the other part the slip required for noise reduction and vibration damping is ensured. The maximum permissible slip S_{max} decreases with increasing rotation rate, but super elevations of the slip curve can be provided in the region of resonance points of the vibrations. The course of the maximum permissible slip S_{max} in dependence upon the rotation rate n is stored in a store 43 of the programme control system 37, especially in tabular form.

The vibration properties of the drive line differ from motor vehicle to motor vehicle as a result of different engine properties, different gear dimensioning, different vehicle equipment, as for example with sliding roof or without sliding roof or different noise absorption measures. In order to take account of these differences the value of the maximum permissible slip S_{max} stored in the store 43 is greater at least in partial rotation rate ranges than would be absolutely necessary for the vibration damping in the concrete case. In order despite this measure to keep the thermal load capacity and wear of the clutch especially low, the programme control system 37 reduces the ideal slip in dependence upon the noise level L detected by means of the acceleration sensor 39. Fig. 3 shows the connection between the slip S of the clutch and the noise level L generated by vibrations of the drive line. With increasing slip the noise level L diminishes. Accordingly a minimum noise level $L_{min.}$ is associated with the maximum permissible slip S_{max}. The programme control system 37 initially sets the clutch 5, as will be explained in greater detail hereinafter, so that it slips with the maximum permissible slip $S_{max.}$ corresponding to the actual rotation rate and accordingly the acceleration sensor 39 detects the minimum noise level $L_{min.}$. Subsequently the programme control system 37 reduces the ideal slip S to a value $S_{min.}$ in dependence upon the noise level L, which here increases from the value $L_{min.}$ to a value $L_{max.}$.

In a first variant of the invention the value $L_{max.}$ is predetermined either as constant value or in a form dependent upon the rotation rate n. The programme control system 37 here generates the slip ideal value signal so that the predetermined noise level $L_{max.}$ is maintained.

In the variant as explained above regulating inaccuracies can occur in some operational situations, especially with greatly fluctuating external noise level. This can be avoided if as provided in a second variant the slip ideal value signal S is reduced, starting from the maximum permissible slip $S_{max.}$, only until the noise level, starting from the minimum noise level $L_{min.}$, is increased by a predetermined level variation value ΔL. Since the noise level $L_{min.}$ also takes account of the external noise level, this variant is independent of the external noise level.

Fig. 4 shows diagrammatically a computer operation diagram for the second variant. In the block diagram the function block 45 designates the start of the internal combustion engine or the beginning of engagement of the clutch. A continuously working function block 47 ascertains a mean value $\bar{n}$ in time over a predetermined time period from the momentary values of the gear-input rotation rate n. The time interval is dimensioned so that fluctuations of the rotation rate by reason of the degree of irregularity of the internal combustion engine are eliminated but the mean value in time of the rotation raten $\bar{n}$ follows a rotation rate varying according to acceleration or braking of the internal combustion engine in dependence upon the accelerator pedal position. In a table store represented as function block 49 a table of the maximum permissible slip values $S_{max.}$ is stored in dependence upon the mean rotation rate $\bar{n}$, the table containing the values $S_{max.}$ in rotation rate steps $\Delta\bar{n}$. After triggering of the function block 47 the function block 49 supplies the value $S_{max.}$, allocated to the momentary rotation rate $\bar{n}$, as ideal value signal which sets the clutch 5 (Fig. 1) to the maximum permissible slip $S_{max.}$. This is indicated by a function block 51. A function block 53, when the clutch is set to the maximum permissible slip, ascertains a mean value in time of the noise level $\bar{L}_{min.}$, which is freed of time fluctuations by reason of the non-uniformity of the internal combustion engine. Cor-

responding to a function block 55, there now follows a slip reduction step in which the clutch is engaged by a predetermined value to reduce the slip. In the step-by-step engagement of the clutch the clutch can be shifted according to a predetermined slip step or a predetermined position step of its releaser or equally by a predetermined slip variation factor or the like. In a decision block 57 it is subsequently tested whether since the ascertaining of the rotation rate $\bar{n}$ in the function block 47 the rotation rate $\bar{n}$ has varied so much that according to the table of the function block 49 another value of the maximum permissible slip $S_{max.}$ should be selected. In other words it is tested whether the mean roration rate $\bar{n}$ still lies within the same table step $\Delta\bar{n}$. If the rotation rate $\bar{n}$ has varied beyond the rotation rate step, the programme springs back to the function block 49. If the rotation rate has not relevantly changed, it is examined in a decision block 59 whether the mean noise level $\bar{L}$, which is ascertained analogously with the function block 53, is less than or equal to the minimum mean noise level $\bar{L}_{min.}$ increased by predetermined constant noise level increment ΔL. The noise level increment ΔL, as explained above, fixes the limit down to which the slip can be reduced starting from the maximum permissible slip $S_{max.}$, if the noise generation and the vibration damping are to remain within predetermined limits. If $\bar{L}$ is less than this limit level, the programme springs into the function block 55 and carries out a further slip-reducing step. The programme works adaptively and in self-regulating manner. If the mean noise level $\bar{L}$ is greater than the above-mentioned limit value, the preceding slip reduction step of the function block 55 is reversed in analogous manner according to a function block 61, the clutch being opened by one step. Here again the opening step can be determined by a constant slip variation step or releaser position variation step or slip variation factor. A decision block 63, following the slip increase step, examines whether the now set slip is less than or equal to the maximum permissible slip $S_{max.}$. If S is less than or equal to S_{max}, the programme is returned to the decision block 57. If S exceeds the maximum permissible slip $S_{max.}$, the programme springs back to the decision block 47.

In the regulating strategy as explained above upon every slip variation step of the function blocks 55 and 61 firstly the reaction of the noise level L must be awaited before the decision block 59 can be interrogated. The time interval necessary for the adjustment of the clutch limits the response time of the regulating arrangement. The response time of the regulation can be shortened by the regulating strategy as explained below. This regulating strategy makes use of the fact that the curve rise of the slip S varies in dependence upon the noise level L. The function course S (L) is dependent upon the rotation rate n and can be ascertained empirically. Accordingly for the roration rate-dependent characteristic of the maximum permissible slip $S_{max.}$ a rotation rate-dependent quotient ΔL: ΔS can be ascertained which satisfies the condition that

$$\frac{\Delta L}{\Delta S} = \frac{L_{max.} - L_{min.}}{S_{max} - S_{min.}}.$$

The quotient $\Delta L/\Delta S$ forms a control parameter limit value which permits, starting from the maximum permissible slip $S_{max.}$, of reducing the slip until the noise level has been increased from its minimum value $L_{min.}$ by the amount ΔL, in which case however it is not necessary to await the reaction of the drive line to slip variations.

Fig. 5 shows a progress diagram corresponding to progress diagram in Fig. 4 for a quotient-dependent regulation system, where function blocks of like function are designated with the same reference numerals increased by the letter a. To explain these function and decision blocks reference is made to the description of Fig. 4. In departure from the table store of the function block 49 the table store of the function block 49a stores not only a table of the maximum permissible slip values $S_{max.}$ in dependence upon the mean rotation rate $\bar{n}$, but also a table of the quotient $\Delta L/\Delta S$ in dependence upon the mean gear-input rotation rate $\bar{n}$. Both tables here have the same stepping distance $\Delta\bar{n}$. After the start of the computer operation by the function block 45a the function block 49a delivers the value of the maximum permissible slip $S_{max.}$ allocated to the ascertained rotation rate $\bar{n}$ and the clutch is set to this value in accordance with the function block 51a. In the function block 53a a momentary value of the quotient of the momentary noise level variation δL in relation to the momentary slip variation δS is ascertained from the momentary values of the slip S and the noise level L and thence a mean time value is formed which is freed from brief fluctuations, such as occur for example by reason of the degree of non-uniformity of the internal combustion engine. When the clutch is set to maximum permissible slip this momentary value of the quotient of the rise of the curve L (S) as represented in Fig. 3, at the point L_{min}, corresponds to $S_{max.}$. The momentary quotient $\delta L/\delta S$ forms the control parameter which, following the slip reduction step of the function block 55a and of the decision-block 57a, is compared in the decision block 59a with the limit value quotient $\Delta L/\Delta S$ taken from the table of the function block 49a. The blocks 55a and 57a here correspond to the blocks 55 and 57 in Fig. 4. In the progress diagram according to Fig. 5 the decision block 59a is followed by a function block 61a with a slip increase step and a decision block 63a

which on increase of the slip monitors the maintenance of the maximum permissible slip S_{max}. The blocks 61a and 63a corresponds to the blocks 61 and 63 in Fig. 4. For the sake of completeness let it be pointed out that the blocks 49a, 53a and 59a can be designed for the monitoring of the inverse quotient. Furthermore the slip regulation was explained above as dependent upon the gear-input rotation rate. Analogously the value of the maximum permissible slip or of the quotient $\Delta L/\Delta S$ used for regulation, stored in the table stores, can also be tabulated in dependence upon the engine rotation rate. The programme control system 37 is correspondingly controlled by the rotation rate sensor 23.

The noise level dependent control ring of the slip ideal value permits a substantially delay-free adaptation of the slip of the friction clutch 5 to changed operational situations for example sudden acceleration. Furthermore the thermal loading of the friction clutch 5 is reduced, since the slip is oriented to the actually generated noise level. The slip regulator circuit is equally suitable for operation of the drive line in traction or equally in over-run.

In Fig. 1 the acceleration sensor 39 detects transverse accelerations of the gear 9. Even though this type of measurement is preferred, any other measurement method for detecting the noises generated by torsion vibrations of the drive line is nevertheless suitable. In Fig. 1 an acceleration sensor fitted on the differential gear 13 is represented at 65 as alternative. Microphones 67 arranged in the passenger compartment of the motor vehicle and detecting the noise level in the passenger compartment are also suitable.

A modulation signal from an oscillator 71 is additionally superimposed through a summation stage 69 on the slip ideal value signal, as Fig. 1 shows, and effects a modulation of the slip of the friction clutch 5. The modulation amplitude is small compared with the slip amplitude. Due to the modulation of the slip the stimulation of inherent frequency vibrations of the drive line can be avoided or at least reduced. The modulation frequency is preferably greater than the ignition frequency of the internal combustion engine 1 and lies expediently at about 2 to 10 times the ignition frequency. The modulation frequency can be variable and especially depend upon the engine rotation rate.

The invention was explained above by reference to the example of a friction clutch forming the change-speed clutch of the drive line. The friction clutch can however also be the by-pass clutch of a torque converter or the like. The by-pass clutch is preferably controlled hydraulically directly by the hydraulic control system of an automatic gear box.

CLAIMS

1. Drive apparatus for a motor vehicle, comprising

a) an internal combustion engine (1),

b) a gear (9),

c) a friction clutch (5) arranged in the torque transmission path between an output-shaft (3) of the internal combustion engine (1) and an input-shaft (7) of the gear (9),

d) a setting drive (15) for the friction clutch (5),

e) a slip sensor apparatus (23, 25, 27) which detects the slip between the output-shaft (3) of the internal combustion engine (1) and the input-shaft (7) of the gear (9),

f) a slip regulating arrangement controlling the setting drive (15) in dependence upon the slip detected by means of the slip sensor device (23, 25, 27), for the generation of a desired slip,

g) a vibration sensor (39, 41; 65; 67) responding to vibrations caused by the internal combustion engine, which sensor controls the magnitude of

the desired slip, fixed by the slip regulating arrangement, in dependence upon the vibration, characterised in that the vibration sensor (39, 41; 65; 67) responds to vibrations of acoustic frequency and generates a signal corresponding to the noise level,

in that the slip-regulating arrangement comprises a rotation-rate sensor (25) detecting the rotation rate (n) at a predetermined point of the torque transmission path and fixes a maximum value (S_{max}) of the desired slip according to a predetermined maximum value characteristic in dependence upon the rotation rate at the predetermined point of the torque transmission path, and in that the slip-regulator arrangement comprises a control system (37, 43) responding to the signal of the vibration sensor (39, 41; 65; 67), which control system sets the magnitude of the desired slip in dependence upon the noise level detected by means of the vibration sensor (39, 41; 65; 67) to a value lower than the maximum value (S_{max}).

2. Drive apparatus according to Claim 1, characterised in that the control system comprises signal transformation means (53; 53a) which generate a control parameter value in dependence upon the signal of the vibration-sensor (39, 41; 65; 67), in that the control system (37) firstly sets the slip regulating arrangement to the maximum value (S_{max}) of the slip fixed according to the predetermined maximum value characteristic and when the friction clutch (5) is slipping in accordance with the maximum value (S_{max}) ascertains a first limit value of the control parameter, in that the control system (37) comprises storage means (43; 49a) which store the information for the generation of a second limit value of the control diameter allocated to a slip lower than the maximum value, and in that the control system (37) then reduces the value of the slip step-by-step until the control parameter value

generated at reduced slip reaches the second limit value.

3. Drive apparatus according to Claim 2, characterised in that the signal transformation means (53) generates a control parameter value ($\bar{L}$) representing the magnitude of the noise level and in that the control system generates as second limit value the first limit value ($\bar{L}_{min.}$) increased by an amount (ΔL) fixed by the information of the storage means (49) and reduces the value of the slip step-by-step until the control parameter value generated at reduced slip is less than the second limit value.

4. Drive apparatus according to Claim 2, characterised in that the signal transformation means (53a) generates a control parameter value representing the quotient of the value of the variation of the noise level (δL) detected by the vibration sensor (39, 41; 65; 67) and of the variation of the slip (S) detected by the slip sensor apparatus (23, 25, 27) and in that the control system (37) reduces the value of the slip step-by-step until the control parameter value reaches the second limit value ($\Delta L/\Delta S$) stored in the storage means.

5. Drive apparatus according to one of Claims 2 to 4, characterised in that the storage means are formed as table storage means (49; 49a) and store the information for the generation of the second limit value in a form dependent upon the rotation rate at the predetermined point of the torque transmission path.

6. Drive apparatus according to one of Claims 2 to 5, characterised in that the signal transformation means (53; 53a) compares the mean time value of the momentary values of the control parameter, related to a predetermined time interval, with the second limit value.

7. Drive apparatus according to one of Claims 1 to 7, characterised in that the slip-regulating arrangement comprises table storage means (49; 49a) for the rotation rate-dependent storage of the maximum values of the desired slip.

8. Drive apparatus according to one of Claims 2 to 7, charcterised in that the slip-regulating arrangement regulates the slip so that the control parameter value is kept substantially constant at the second limit value.

9. Drive apparatus according to one of Claims 1 to 8, characterised in that the rotation rate sensor (25) generates a signal corresponding to the rotation rate of the input (7) of the gear (9).

10. Drive apparatus according to one of Claims 1 to 9, characterised in that the vibration sensor is formed as acceleration sensor (39; 65) which responds to vibration accelerations of the gear (9) or of a differential gear (13) directed substantially horizontally and transversely of the direction of travel.

11. Drive apparatus according to one of Claims 1 to 9, characterised in that the vibration sensor is formed as a microphone (67) arranged in the passenger compartment of the motor vehicle.

12. Drive apparatus according to one of Claims 1 to 11, characterised in that the slip-regulating arrangement comprises a modulation arrangement (69, 71) which superimposes a modulation signal of smaller amplitude upon a control signal controlling the setting drive (15).

13. Drive apparatus according to Claim 12, characterised in that the frequency of the modulation signal is greater than the ignition sequence frequency of the internal combustion engine (1).

14. Drive apparatus according to Claim 13, characterised in that the frequency of the modulation signal is two to ten times the ignition sequence frequency.

15. Drive apparatus for a motor vehicle as claimed in Claim 1 substantially as described with reference to Fig. 1 of the accompanying drawings.

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